APPENDIX B

Eddy-Covariance Measurements Now Confirm Estimates of Carbon Sinks from Forest Inventories

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Long-term, tower-based, eddy-covariance measurements (*e.g.*, Wofsy *et al.*, 1993) represent an independent approach to measuring ecosystem-atmosphere carbon dioxide (CO_2) exchange. The method describes fluxes over areas of approximately 1 km² (Horst and Weil, 1994), measures hour-by-hour ecosystem carbon fluxes, and can be integrated over time scales of years. A network of more than 200 sites now exists globally (Baldocchi *et al.*, 2001); more than 50 of these are in North America. None of these sites existed in 1990, so these represent a relatively new source of information about the terrestrial carbon cycle. An increasing number of these measurement sites include concurrent carbon inventory measurements.

Where eddy-covariance and inventory measurements are concurrent, the rates of accumulation or loss of biomass are often consistent to within several tens of g C per m² per year for a one-year sample (10 g C per year is 5% of a typical net sink of two metric tons of carbon per hectare per year for an Eastern deciduous successional forest). Published intercomparisons in

North America exist for western coniferous forests (Law *et al.*, 2001), agricultural sites (Verma *et al.*, 2005), and eastern deciduous forests (Barford *et al.*, 2001; Cook *et al.*, 2004; Curtis *et al.*, 2002; Ehmann *et*

Table B.1 Carbon budget for Harvard Forest from forest inventory and eddy-covariance flux measurements, 1993-2001. Source: Barford *et al.* (2001), Table 1. Numbers in parentheses give the ranges of the 95% confidence intervals. Following the sign convention in Barford *et al.* (2001), positive values represent uptake from the atmosphere (*i.e.*, a sink) and negative values a release (*i.e.*, a source).

Component	Change in carbon stock or flux (Mg C per ha per year)[a]	Totals

Change in live biomass
  A. Above-ground
    1. Growth
    2. Mortality
  B. Below-ground (estimated)
    1. Growth
    2. Mortality
Subtotal
	
	1.4 (±0.2)
	−0.6 (±0.6)
	
	0.3
	−0.1
	
		1.0 (±0.2)

Change in dead wood
  A. Mortality
    1. Above-ground
    2. Below-ground
  B. Respiration
Subtotal
	
	0.6 (±0.6)
	0.1
	−0.3 (±0.3)
	
		0.4 (±0.3)

Change in soil carbon (net)		0.2 (±0.1)
Sum of carbon budget figures		1.6 (±0.4)
Sum of eddy-covariance flux measurements		2.0 (±0.4)

[a] 1 Mg C per ha per year = 100g C per m² per year.

al., 2002; Gough *et al.*, in review). Multiyear studies at two sites (Barford *et al.*, 2001; Gough *et al.*, in review) show that 5- to 10-year averages converge toward inventory measurements. Table B.1 from Barford *et al.* (2001) shows the results of nearly a decade of concurrent measurements in an eastern deciduous forest.

This concurrence between eddy-covariance flux measurements and ecosystem carbon inventories is relevant because it provides independent validation of the inventory measurements used to estimate long-term trends in carbon stocks. The eddy-covariance data are also valuable because the assembly of global eddy-covariance data provides independent support for net storage of carbon by many terrestrial ecosystems and the substantial year-to-year variability in this net sink. The existence of the eddy-covariance data also makes the sites suitable for co-locating mechanistic studies of interannual and shorter, time-scale processes governing the terrestrial carbon cycle. Chronosequences show trends consistent with inventory assessments of forest growth, and comparisons across space and plant functional types are beginning to show broad consistency. These results show a consistency across a mixture of observational methods with complementary characteristics, which should facilitate the development of an increasingly complete understanding of continental carbon dynamics (Canadell *et al.*, 2000).